In the Specification:

Please replace the following paragraphs:

a1

[0020] Like most of the ABS control algorithm, the current controller also requires the knowledge of wheel slip. The objective of the controller is to keep the wheel slip at a value that would maximize the tire-road adhesion (or minimize the tire slip). This is unlike previously known systems that oscillate greatly and have greater variations in slip angles. Normalized tire slip is obtained from the following definition:

$$\cancel{\kappa_i(t) = \frac{V-R}{V}}$$

$$\underline{\kappa_i(t) = \frac{V-R\omega_i}{V}} \qquad (1)$$

where

R = Effective rolling radius for the tire

ω_i = Wheel rotational speed for i-th tire

V = Vehicle longitudinal speed in road co-ordinate system.

a2

[0021] It is necessary to obtain the dynamic equations for the vehicle motion in order to develop the control algorithm. A simplified vehicle model is obtained for a straight line braking event. The vehicle motion in the longitudinal direction on the road plane is described by the following equation.

$$\cancel{\sum F_{xr} = F_{xsumr} + F_{txr} - F_{axr} = M(\dot{V} - V_y r_r) + m_s \dot{Z}_{sr}}$$

$$\underline{\sum F_{xr} = F_{xsumr} + F_{txr} - F_{axr} = M(\dot{V} - V_y r_r) + m_s \dot{Z}_{sr} q_r}$$

where

F_{xsumr} = sum of road forces in the x-direction at the road tire interfaces

F_{txr} = Terrain forces at the c.g. arising out of road slopes and grades

F_{axr} = Aerodynamic drag forces on the vehicle

M = Total vehicle mass

$\dot{V}$ = Vehicle longitudinal velocity

V_y = Vehicle lateral velocity

r_r = Vehicle yaw velocity

m_s = Sprung mass of the vehicle

a2 cont

~~$_s$ = Sprung mass velocity in the~~

$\dot{Z}_{sr}$ = Sprung mass velocity in the

q_r = Pitch velocity of the sprung mass.

[0022] The wheel rotational dynamics shown in Figure 2 are given by the following equation:

$$\cancel{\sum M_y = T_{bi} \quad F_{xi}R \quad F_{rri}R \quad T_{di} = \quad I_{wi\ i}}$$

$$\sum M_y = T_{bi} - F_{xi}R - F_{rri}R - T_{di} = -I_{wi}\dot{\omega}_i$$

where

T_{bi} = Brake torque at i-th wheel

ω_i = Angular speed of i-th wheel

F_{xi} = Longitudinal friction force at i-th tire contact patch

R = Effective wheel rolling radius

F_{rri} = Rolling Resistance at i-th tire contact patch

T_{di} = Drive torque at i-th wheel

I_{wi} = i-th wheel rotational inertia

$\dot{\omega}_i$ = Angular acceleration of i-th wheel.

a3

[0023] For a braking event, the following set of equations of motion is written.

$$\cancel{F_{xsumr} + F_{txr} \quad F_{axr} = M(\dot{V} \quad V_y r_r) + m_s \dot{Z}_{sr}}$$

$$\cancel{T_{bi} \quad F_{xi}R \quad F_{rri}R \quad T_{di} = \quad I_{wi}}$$

$$F_{xsumr} + F_{txr} - F_{axr} = M(\dot{V} - V_y r_r) + m_s \dot{Z}_{sr} q_r$$

$$T_{bi} - F_{xi}R - F_{rri}R - T_{di} = -I_{wi}\dot{\omega}_i \qquad (2)$$

a3 cont

The pitch dynamics of the vehicle in the first equation is assumed to have negligible effect on the wheel braking forces. For the sake of simplicity, the effect of t rrain forces arising out of road slopes and grades are also neglected. The drive torque (in a braking situation) is assumed to be insignificant in the second equation. Further simplification is made by assuming that the steer wheel angle is zero resulting in zero lateral motion. Also, the following relationships are defined:

$F_{xi} = \mu_i F_{zi}$; $F_{rri} = \eta F_{zi}$

where $\mu_i(\kappa)$ = Friction Coefficient and η = Rolling Resistance Coefficient.

a4

[0026] The simplified equations of motion are then given by:

$$\cancel{-\sum \mu_i(\kappa_i) F_{zi} = M\dot{V}}$$
$$\cancel{T_{bi} - \mu_i(\kappa_i) F_{zi} R = -I_{wi}}$$

$$\underline{-\sum \mu_i(\kappa_i) F_{zi} = M\dot{V}}$$
$$\underline{T_{bi} - \mu_i(\kappa_i) F_{zi} R = -I_{wi}\dot{\omega}_i}$$

a5

[0031] The sliding surface may be defined as follows,

$$\cancel{S = (\kappa_{th} - \kappa)}$$
$$\underline{S = (\kappa_{th} - \kappa_i)} \qquad (7)$$

a6

[0032] It is assumed here that the desired slip is the same as the slip threshold. With the above definition of the sliding surface, the sliding mode control law is given by,

$$\cancel{\dot{S} = -\eta SAT(}$$

$$\underline{\dot{S} = -\eta SAT(\frac{S}{\phi})}$$

where

$$\eta = Convergence\ \ Factor;\ \phi = Boundary\ \ Layer\ \ Thickness$$

Further simplifying,

a4 cont

$$\dot{\kappa}_{th} - \frac{R}{I_{wi}}\frac{1}{V}T_{bi} + \frac{R^2}{I_{wi}}\frac{1}{V}\alpha_{si}\kappa_i F_{zi} + \frac{R\omega_i}{V^2}\frac{1}{M}\sum \alpha_{si}\kappa_i F_{zi} = -\eta SAT\left(\frac{\kappa_{th}-\kappa_i}{\phi}\right) \tag{8}$$

Hence the control law is given by,

$$T_{bi} = \frac{VI_{wi}}{R}\dot{\kappa}_{th} + R\alpha_{si}\kappa_i F_{zi} + \frac{I_{wi}}{V}\frac{\omega_i}{M}\sum \alpha_{si}\kappa_i F_{zi} + \eta\frac{I_{wi}}{R}V * SAT\left(\frac{\kappa_{th}-\kappa_i}{\phi}\right) \tag{9}$$

a7

[0033] If κ_{th} is a constant, then the above control law becomes,

$$\cancel{T_{bi} = R\alpha_{si}\kappa_i F_{zi} + \frac{I_{wi}}{V}\frac{\omega_i}{M}\sum \alpha_{si}\kappa_i F_{zi} + \eta\frac{I_{wi}}{R}V * SAT\left(\frac{\kappa_{th}-\kappa}{\phi}\right)}$$

$$\underline{T_{bi} = R\alpha_{si}\kappa_i F_{zi} + \frac{I_{wi}}{V}\frac{\omega_i}{M}\sum \alpha_{si}\kappa_i F_{zi} + \eta\frac{I_{wi}}{R}V * SAT\left(\frac{\kappa_{th}-\kappa_i}{\phi}\right)} \tag{10}$$

a8

[0034] Equation (10) is the proposed control law for the anti-lock braking system. As can be seen the brake torque (and the corresponding pressure) is dependent upon the normal force of the tire F_{zi} the tire slip and the value ~~chose~~ chosen for the peak slip angle.